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(54) Drilling methods and equipment

(57) A cutting adaptor (4) mounted adjacent to a cutting bit (1), of a drill string excavating rock or mineral to form a borehole, is provided with radially outwardly extendable cutting elements (20) arrangeable to enlarge the diameter of the borehole (10, 11). In a second operational mode the cutting elements can be withdrawn. The cutters (20) are extended and retracted by movement of a stepped plunger (30).

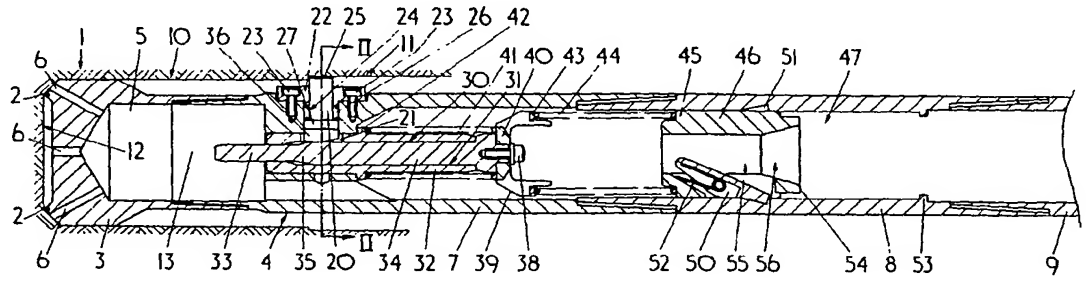

FIG. 1

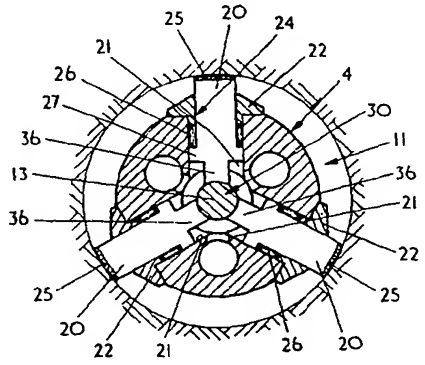

FIG.2

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

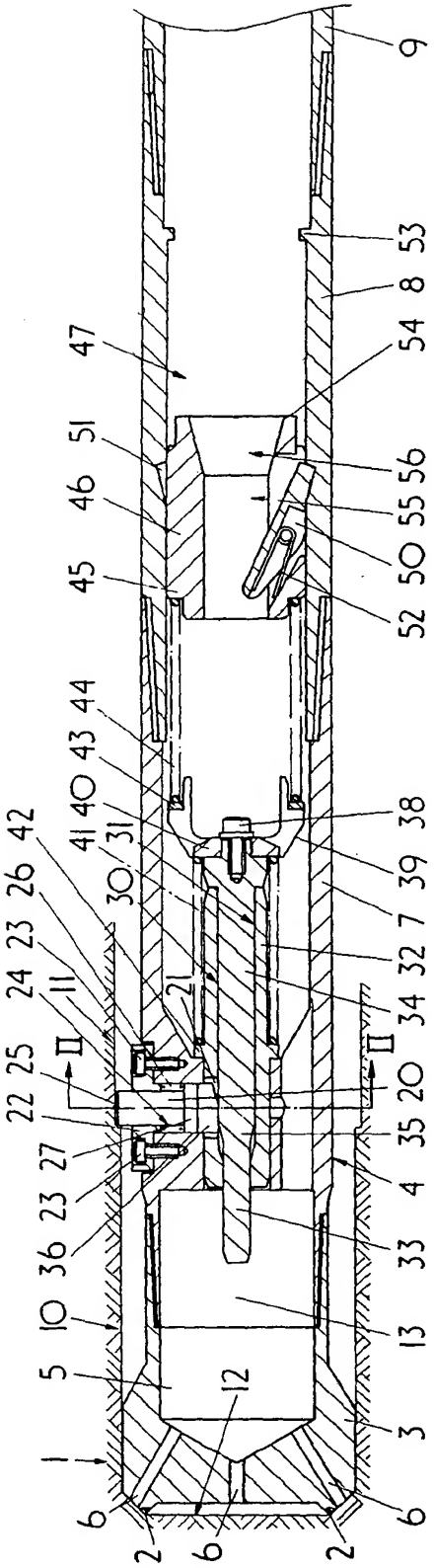
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FIG. 1

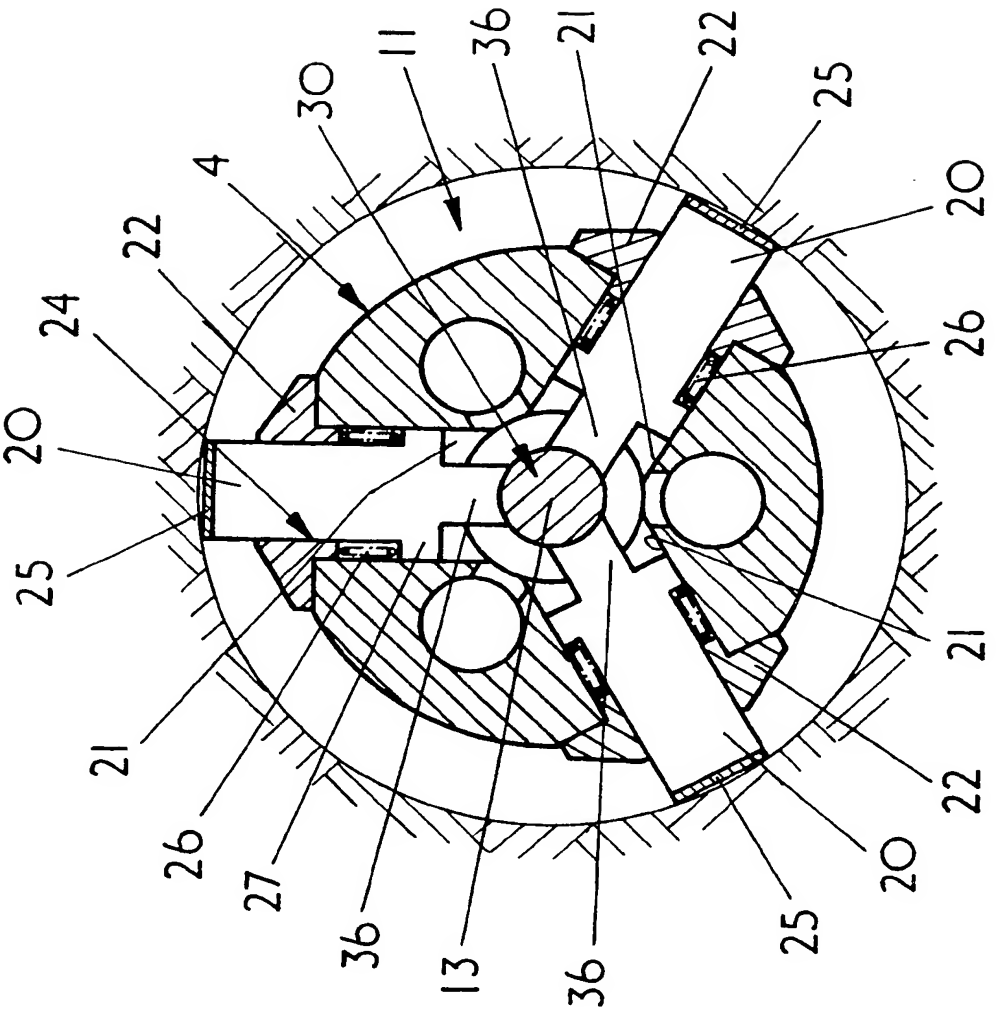

FIG.2

SPECIFICATION

Drilling methods and equipment

This invention relates to drilling methods and equipment.

In particular, although not exclusively, the present invention relates to drilling methods and equipment for drilling long exploratory bore holes in rock strata.

It is known for such drilling equipment to comprise a rotary drill bit mounted on the end of an extensible drill rod constituted by a plurality of connected drill rod sections which are rotated by a drilling machine and which are introduced into the generally horizontally extending borehole to increase its length. It is common practice for the drill bit to have an overall diameter slightly greater than that of the drill rod and for collars or stabilisers to be fitted around the end portion of the drill rod adjacent to the drill bit in order to determine the cutting horizon of the drill bit. Depending upon whether the drill operator desires the drill bit to be urged to move upwardly or downwardly relatively to the adjacent rock strata, the axial positions of these stabilisers relative to the bit must be varied.

A problem with the use of such collars is that in order to reposition these collars it is necessary to withdraw all the strings of assembled drill rods. It will be appreciated that this can be a time consuming and tedious operation particularly when the borehole is very long and particularly when the original type of adaptor might have to be refitted once the correct or desired cutting orientation or horizon is achieved.

An object of the present invention is to provide improved drilling equipment.

According to one aspect of the present invention a method of drilling a borehole in rock strata comprises the steps of directing a rotary drill string including a drilling bit to excavate the borehole, and providing the drill string with a cutting adaptor arranged to rotate with the drilling bit and having two alternative operational modes, in the first mode of which radially mounted cutter means are urged to extend outwardly to enlarge the diameter of the newly excavated portion of the borehole, and in the second operational mode of which the cutter means are withdrawn, means being provided for controlling the operational mode of the cutting adaptor.

Preferably, the means is activated by probe means fed down the borehole.

Alternatively the means is activated by remote control means.

According to a second aspect of the present invention drilling equipment for excavating a borehole comprises a cutting adaptor arranged to rotate with a rotary drilling bit mountable on a rotary drill rod string for excavating the borehole, the cutting adaptor having two alternative operational modes, in the first mode of which radially mounted cutter means are urged to extend outwardly to enlarge the diameter of a newly excavated portion of the borehole, and in the second operational mode of which the cutter means are withdrawn, and means for controlling the operational mode of the cutting adaptor.

Preferably, the cutter means comprises a plurality of radially mounted and angularly spaced cutter elements.

Preferably, the cutter elements are resiliently biassed towards a withdrawn mode.

Preferably, the means comprises a movable plunger and releasable latch means, said means having two operational modes in the first mode of which the plunger is retained by the action of the engaged latch means in a position urging the cutter elements to extend radially outwardly and in the second mode of which the plunger is released by the latch means to a position allowing the cutter elements into the withdrawn mode under the action of the resilient bias.

Preferably, the plunger is stepped.

Preferably, the releasable latch means comprises a pivotally mounted latch.

Advantageously, the pivotally mounted latch is resiliently biassed into one of its operational modes.

Conveniently, probe means are provided comprising a releasing element for urging the pivotally mounted latch to move against its resilient bias.

Advantageously, the retaining latch is mounted on a slidable bush.

Preferably, resilient means are provided between the bush and the plunger.

By way of example, one embodiment of the present invention described with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section taken through a portion of a drill rod string including a drilling bit; and

Figure 2 is a section taken along line II—II of Figure 1.

Figure 1 shows the portion of a drill rod string of borehole drilling equipment adjacent to a drilling bit 1 having cutting tips 2 for excavating rock or mineral strata to extend the borehole 10, 11. The bit comprises a generally cylindrical body 3 having a threaded section for drivable engagement with a cutting adaptor 4 (described later in the specification) and having a hollow bore 5 interconnected to fluid passage 6 for feeding pressurised hydraulic fluid to wash away broken rock or mineral particles, the particles being washed down the outside of the cutting bit along the borehole.

The cutting adaptor 4 comprises an elongated generally cylindrical barrel component 7 having threaded end sections for drivable connection to the cutting bit and to an adjacent adaptor 8 discussed later in the specification. In similar manner a drill rod 9 has threaded end sections for drivable connection to the adaptor 4 and to an adjacent drill rod 9 extending further along the borehole. The drill rod string is made up of a plurality of drill rods similar to rod 9 connected end to end and rotated about the longitudinal axis 13 of the borehole by a drilling machine (not

shown) located adjacent to the mouth of the borehole. Simultaneously, to the drilling machine rotating the drill string it urges the string along the borehole to monitor the cutting elements 2 of the bit 1 in cutting engagement with the end face 12 of the borehole.

The cutting adaptor 4 is provided with radially mounted cutting means comprising three radially extending and angularly spaced cutting elements 20 (see Figures 1 and 2) slidably mounted in radially extending bores 21 provided in the adaptor body. The radially outermost ends of the bores 21 are partially closed by caps 22 fixedly secured to the adaptor body by screws 23 and having through bores 24 from the radially outermost cutting tips 25 of the cutting elements. The tips are formed with hard material to increase their operational life.

A spring 26 is trapped between each end cap 22 and an abutment shoulder 27 provided on the associated cutting element, the action of the spring tending to urge the cutting element radially inwards along the bores 21, 24 into a withdrawn position in which the cutting tip 25 is radially within the cut boundary profile of the borehole section 10 newly excavated by the cutter bit. Preferably, the cutting tips are parallel with or within the radially outer surface of the end caps 22.

The cutting elements can be urged into a radially outwardly extended mode (as seen in Figures 1 and 2) in which the cutting tips 25 are in cutting engagement with the outer boundary profile 10 newly excavated by the cutting bit 1 such that the diameter of the borehole is increased. An increased diameter portion of the borehole is indicated by reference number 11.

The cutting elements are urged into the radially outwardly extended cutting mode against the action of the springs 26 by a generally cylindrical, stepped plunger 30 slidably engaged for longitudinal movement in a bore 31 provided in a fixed barrel 32. The plunger 30 has a relatively small diameter section 33 and a relatively large diameter section 34 connected by a tapered section 35 arranged for co-operation with a tapered foot 36 on each of the cutting elements.

In Figures 1 and 2 the plunger is shown in its forward mode with the sheet 36 of the cutting elements abutted by the relatively large diameter section 34 so that the cutting elements are urged against the action of springs 26 to extend radially outwardly into the cutting mode. When the plunger is slid rearwardly the feet 36 slide along the plunger down the tapered section 35 to abut the relatively small diameter section 33. With the plunger in the rearward position the cutting elements are moved under the action of the springs 26 into a withdrawn mode in which the cutting tips are clear of the boundary profile cut by the cutting bit.

The rearward most end of the plunger 30 is fixedly connected by bolt 38 to a spring retainer 39 having an abutment shoulder 40 for engagement with one end of a spring 41. The other end of the spring 41 abuts an abutment shoulder 42 provided on the barrel 32. The spring retainer 39 also has a further abutment shoulder 43 for engagement with one end of a second spring 44. The other end of the spring 44 abuts an abutment shoulder 45 provided on a bush component 46 slideably mounted with the bore 47 of the drill rod 8. In the drawings the bush component is shown in its forwardmost position fully compressing the springs 41, 44 and retaining the plunger in its forwardmost mode. The bush component is releasably retained in the forwardmost position by releasable latch means comprising a pivotally mounted latch 50 which is urged to pivot outwardly into its locked mode (as seen in the drawings) with the end of the latch abutting an annular recess 51 in the inner wall of the adaptor bore 47 under the action of a spring 52. Although in Figure 1 only one releasable latch mechanism is shown, in practice a total of three angularly spaced latch mechanisms may be used.

Rearward movement of the released bush component 50 is limited by an inwardly directed abutment stop 53 arranged to abut an annular shoulder 54 provided on the bush component. The bush component 50 also is provided with a through bore 55 having an outwardly tapered inlet 56 for a probe (not shown) which can be inserted along the hollow bore of the drill string to engage in the bore 55. If the bush component is in an engaged mode as shown in Figure 1 of the drawings, the nose of the probe enters the bore 55 via the tapered inlet 56 and abuts the inwardly directed latches 50 which thereby are provided against the action of the springs 52 such that the outermost ends of the latches clear the recess 51. Thus, when the probe is withdrawn from the borehole, the bush component is urged by the action of the springs 41, 44 rearwardly into contact with the abutment stop 53. The release of the bush component 50 causes the spring 41 to urge the plunger 30 rearwardly along the bore 31 until the feet of the cutting elements engage the relatively small diameter section 33 permitting the cutting elements to be withdrawn under the action of the springs 26.

When it is desired to move the cutting elements back into a cutting mode, the probe is re-inserted along the borehole. However, in this instance the nose of the probe is removed or turned around. The inserted probe contacts the end abutment face 60 of the bush component which thereby is urged against the action of the spring 41, 44 until the latches encounter the recess 51 and are urged outwardly to engage the recess under the action of the springs 52. With the bush component in this locked mode the plunger is urged forwardly by the action of the springs 41, 44 such that the feet 36 of the cutting elements slide up the tapered section of the plunger to the relatively large diameter section. Thus, the cutting elements are extended radially outward into a cutting mode.

In use, with the cutting element withdrawn and a smooth walled bit fitted to the drill rod string

(i.e. a cutting bit with little or no cutting means on the outside diameter there is a tendency for the drill rods to sag in the borehole thereby inclining the bit upwards. The upward action can be increased or reduced as desired by suitably varying the speed of drilling. Thus, with the cutting element withdrawn the drill bit can be steered upwards.

If, in use it is desired to steer the drill bit downwards, the bush component and plunger are moved into their forwardmost positions such that the cutting elements are urged to extend radially outwardly into their cutting mode to enlarge the borehole diameter. The effect of increasing the borehole diameter permits the leading portion of the drill rod string to move downwardly towards the newly excavated floor of the borehole. Thus, the drill bit progressively is steered downwards.

When it is desired to drill substantially horizontally, it may be necessary to fit another bit including vanes for urging cut material away from the drill bit.

In other embodiments of the invention, the releasable latch means is actuated by remote control means, the latch means including a mechanism responsive to signals from the remote control means.

Claims

1. A method of drilling a borehole in rock or mineral strata comprises the steps of directing a rotary drill string including a drilling bit to excavate the borehole, and providing the drill string with a cutting adaptor arranged to rotate with the drilling bit and having two alternative operational modes, in the first mode of which radially mounted cutter means are urged to extend outwardly to enlarge the diameter of the newly excavated portion of the borehole and in the second operational mode of which the cutter means are withdrawn, means being provided for controlling the operational mode of the cutting adaptor.

2. A method as claimed in claim 1, wherein the means is activated by probe means fed down the borehole.

3. A method as claimed in claim 2, wherein the means is activated by remote control means.

4. Drilling equipment for excavating a borehole, comprising a cutting adaptor arranged to rotate with a rotary drilling bit mountable on a rotary drill rod string for excavating the borehole, the cutting adaptor having two alternative operational modes, in the first mode of which radially mounted cutter means are urged to extend outwardly to enlarge the diameter of a newly excavated portion of the borehole, and in the second operational mode of which the cutter means are withdrawn, and means for controlling the operational mode of the cutting adaptor.

5. Drilling equipment as claimed in claim 4, in which the cutter means comprises a plurality of radially mounted and angularly spaced cutter elements.

6. Drilling equipment as claimed in claim 5, in which the cutter elements are resiliently biassed towards a withdrawn mode.

7. Drilling equipment as claimed in claim 6, in which the means comprises a movable plunger and releasable latch means, said means having two operational modes in the first mode of which the plunger is retained by the action of the engaged latch means in a position urging the cutter elements to extend radially outwardly and in the second mode of which the plunger is released by the latch means to a position allowing the cutter elements into the withdrawn mode under the action of the resilient bias.

8. Drilling equipment as claimed in claim 7, in which the plunger is stepped.

9. Drilling equipment as claimed in claim 7 or 8, in which the releasable latch means comprises a pivotally mounted latch.

10. Drilling equipment as claimed in claim 9, in which the pivotally mounted latch is resiliently biassed into one of its operational modes.

11. Drilling equipment as claimed in claim 10, in which probe means are provided comprising a releasing element for urging the pivotally mounted latch to move against its resilient bias.

12. Drilling equipment as claimed in claim 11, in which the retaining latch is mounted on a slidable bush.

13. Drilling equipment as claimed in claim 12, in which resilient means are provided between the bush and the plunger.

14. A method of drilling a borehole in rock or mineral strata, substantially as described herein with reference to the accompanying drawings.

15. Drilling equipment for excavating a borehole in rock or mineral strata substantially as described herein and substantially as shown in the accompanying drawings.

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